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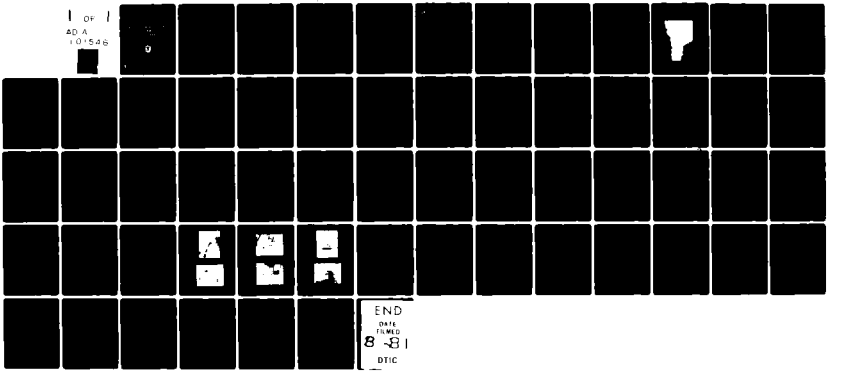

HUDSON RIVER BASIN
TRIBUTARY TO WARWICK CREEK
SUSSEX COUNTY
NEW JERSEY

EAST HIGHLAND LAKE DAM
NJ 00288

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

DACW61-79-C-0011

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

REPT. NO: DAEN/NAP-53842/NJ00288-81/07

JULY 1981

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18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams	National Dam Safety Program
Embankments	East Highland Lake Dam, N.J.
Visual Inspection	Erosion
Structural Analysis	Spillways

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-N

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for East Highland Lake Dam, Sussex County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, East Highland Lake Dam, initially listed as a high hazard potential stucture but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in fair overall condition and the spillway is considered adequate. To ensure the adequacy of the structure the following remedial actions are recommended:

a. The eroded areas and displaced riprap on the upstream face of the dam should be filled and compacted with suitable embankment material and the riprap repositioned or replaced within thirty days from the date of approval of this report.

b. The following remedial actions should be initiated within six months from the date of approval of this report:

(1) Remove all trees and brush from the dam, refill and regrade the dam crest, and reestablish a firm grass cover over the entire embankment.

(2) Debris should be removed from the spillway and downstream channel.

(3) The blow-off gate valve should be repaired and tested, the manhole cover replaced, the displaced block at the top of the manhole repaired and the debris therein removed.

NAPEN-N
Honorable Brendan T. Byrne

(4) The deteriorated concrete at the spillway should be repaired.

(5) The drain pipe should be cleared of accumulated silt and debris.

c. The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam within one year from the date of approval of this report.

d. An emergency action plan and warning system should be developed which oulines actions to be taken to minimize the downstream effects of an emergency at the dam within six months from the date of approval of this report.

A copy of the report is being furnished to Mr. Dirk C. Hotman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Courter of the Thirteenth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Inspection Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

Kenneth R Mosse - Maj CE, DC

for JAMES G. TON
Colonel, Corps of Engineers
Commander and District Engineer

1 Incl
As stated

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
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N.J. Dept. of Environmental Protection
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Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
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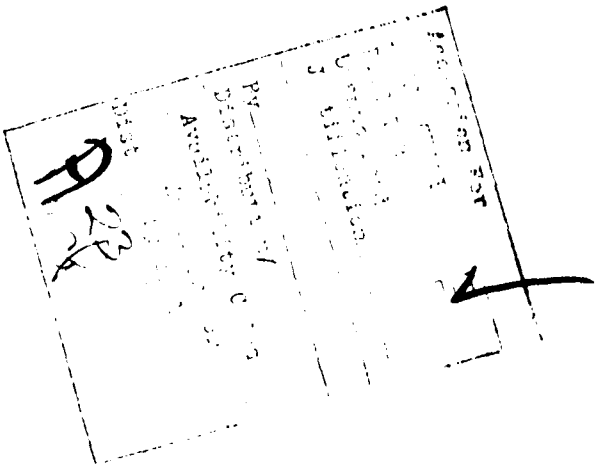

EAST HIGHLAND LAKE DAM (NJ00288)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 24 March 1981 by Louis Berger and Associates, Inc. under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

East Highland Lake Dam, initially listed as a high hazard potential stucture but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in fair overall condition and the spillway is considered adequate. To ensure the adequacy of the structure the following remedial actions are recommended:

a. The eroded areas and displaced riprap on the upstream face of the dam should be filled and compacted with suitable embankment material and the riprap repositioned or replaced within thirty days from the date of approval of this report.

b. The following remedial actions should be initiated within six months from the date of approval of this report:

(1) Remove all trees and brush from the dam, refill and regrade the dam crest, and reestablish a firm grass cover over the entire embankment.

(2) Debris should be removed from the spillway and downstream channel.

(3) The blow-off gate valve should be repaired and tested, the manhole cover replaced, the displaced block at the top of the manhole repaired and the debris therein removed.

(4) The deteriorated concrete at the spillway should be repaired.

(5) The drain pipe should be cleared of accumulated silt and debris.

c. The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam within one year from the date of approval of this report.

d. An emergency action plan and warning system should be developed which oulines actions to be taken to minimize the downstream effects of an emergency at the dam within six months from the date of approval of this report.

APPROVED: Kenneth R Mossman, Jr CE, DC
for JAMES G. TON
Colonel, Corps of Engineers
Commander and District Engineer

DATE: 1 July 1981

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam East Highland Lake Dam Fed ID# NJ 00288
NJ ID# 22-154

State Located	New Jersey
County Located	Sussex
Coordinates	Lat. 4110.5 - Long. 7438.2
Stream	Tributary to Warwick Creek
Date of Inspection	March 24, 1981

ASSESSMENT OF GENERAL CONDITIONS

East Highland Lake Dam is considered to be in fair overall condition and has a spillway capacity that will accommodate the 100-year design flood. It is recommended that the dam be evaluated within the framework of the significant hazard classfication since its failure could result in damage to several residences and a local road immediately downstream. Remedial work requiring immediate attention includes the repair of the eroded portions of the embankment and replacement of the riprap in those areas. Repairs to be made in the near future include removal of trees and brush from the dam; removal of debris from the spillway, downstream channel, gate valve manhole, and drain pipe; repair of all deteriorated concrete at the spillway and manhole; and repair of the gate valve for the blow-off pipe. It is further recommended that the owners develop a periodic maintenance plan and operational procedures and prepare an emergency action plan and downstream warning system.

Abraham Perera P.E.
Project Manager

OVERVIEW OF EAST HIGHLAND LAKE DAM

MARCH, 1981

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines can be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of Phase I investigations is to identify expeditiously those dams that may pose hazards to human life or property. The assessment of the general condition of the dam is based on available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In the review of this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions will be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway test flood is based on the estimated "probable maximum flood" for the region (greatest reasonable possible storm runoff) or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
NAME OF DAM: EAST HIGHLAND LAKE DAM FED ID# NJ 00288
AND NJ ID # 22-154

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract FPM-36 betwen Louis Berger & Associates, Inc. and the State of New Jersey and its Department of Environmental Projection, Division of Water Resources. The State, in turn, is under agreement with the U.S. Army Engineer District, Philadelphia to have this inspection performed.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of the East Highland Lake Dam and appurtenant structures and to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

East Highland Lake Dam is a 550-foot-long earth structure with a concrete spillway located at the left abutment. The embankment, which has a maximum height of 15 feet, is also 15 feet wide at the crest with 2H:1V side slopes. This three-zoned structure rests on bedrock at both abutments and has an impermeable, puddled-clay core and cutoff trench, a pervious earth downstream embankment, and an impervious clay-fill embankment upstream. The 30-foot-long spillway rests on bedrock and has a 5-foot-long, 0.4-foot-deep weir notch located in its center. The spillway outfall, which is constructed of grouted masonry paving, extends around the left end of the dam's toe to a natural stream channel about 175 feet from the left abutment. Concrete wingwalls extending along both sides of the outfall

to the toe of the dam channelize the discharge. A 60-foot-long concrete cutoff adjoins the spillway and extends from the crest of the dam down to bedrock. A 12-inch-diameter gate-operated steel pipe at invert elevation 100 functions as a low-level drain.

b. Location

The dam is located across a tributary to Warwick Creek at the north end of East Highland Lake in the community of Highland Lakes, Vernon Township, Sussex, New Jersey. It is 2 miles east of the intersection of County 515 and Breakneck Road and is centrally located between Highland Lake, Lake Wanda, and Wawayande Lake. The dam may be reached via a private driveway at the north end of West Lakeside Drive.

c. Size Classification

The dam at East Highland Lake has a maximum height of 15 feet and a maximum storage capacity of 244 acre-feet. Accordingly, this dam is in the small size category as defined by the criteria in the Recommended Guidelines for Safety Inspection of Dams (storage less than 1,000 acre-feet and height less than 40 feet).

d. Hazard Classfication

The dam is located in a relatively populated residential lake community. The downstream valley is approximately 200 feet wide for about 800 feet below the dam, at which point the stream passes under a small local road and enters a very large, essentially uninhabited marsh. There are several homes located along the sides of the valley that are 6 to 8 feet above the small, shallow stream channel. There are also two occupied house trailers near the road that are about 6 feet above the stream. It is the opinion of the inspection team that while loss of life is not highly probable, any of the downstream structures could sustain extensive flood damage in the event of a dam failure. Accordingly, it is recommended that the dam be evaluated within the framework of the significant hazard category.

e. Ownership

This dam is owned by the Highland Lakes Country & Community Association Inc., Highland Lakes, New Jersey, 07422.

f. Purpose of Dam

The purpose of the dam is to impound a recreational lake.

g. Design and Construction History

The dam was designed in 1946 by Newell C. Harrison, P.E. for the Highland Lakes Association of Vernon Township. Construction began in October 1946 and was completed in February 1947. Construction modifications of the original design consisted of replacement of steel or concrete sheeting with an impermeable clay cutoff and a change in the configuration and location of the spillway due to the occurrence of bedrock at unanticipated elevations.

h. Normal Operating Procedures

There are presently no formal operating procedures. However, a full-time maintenance crew is employed by the Lake Association for groundskeeping and repair of community property.

1.3 PERTINENT DATA

a. Drainage Area

East Highland Lake Dam has a drainage area of 0.5 square miles, which consists of wooded hills and marshland.

b. Total spillway capacity at maximum pool elevation (top of dam) - 481 cfs

c. Elevations (assumed datum)

Top of dam	- 115.0
Principal spillway crest	- 111.7
Streambed at centerline of dam	- 100.0

d. Reservoir

Length of maximum pool (top of dam)	- 3,025 feet
Length of recreation pool (principal spillway crest)	- 2,950 feet

e. Storage (acre-feet)

Top of dam	- 244
Recreation pool	- 160

f. Reservoir Surface (acres)

Top of dam - 29.6
Recreation pool - 26.6

g. Dam

Type - Earth embankment with a concrete, narrow-crested weir for a primary spillway

Length - 550 feet

Height - 15 feet

Top width - 15 feet

Side slopes - 2H:1V

Zoning - Three zone construction: impervious puddled clay core; impervious rolled clay fill in upstream embankment; and pervious earth fill in downstream embankment

Impervious blanket - None

Cutoff - Puddled clay cutoff trench beneath clay core

Grout curtain - None

Corewall - Concrete corewall, 60 feet long, adjoining spillway

h. Diversion and Regulating Tunnel

Type - None

i. Spillway

Type - Concrete weir with center notch

Weir length - 30 feet

Notch length - 5 feet

Notch depth - 0.4 feet

Gates - None

U/S Channel - Not applicable

D/S Channel - Grouted masonry spillway apron with concrete wingwalls extending to natural channel downstream of dam toe

J. Regulating Outlets

Lake level regulated by 12-inch-diameter steel pipe located about 80 feet from left abutment at exit invert elevation 100. Concrete valve chamber located on downstream slope of dam.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Details of the original 1946 design plans and the 1947 as-built drawings were available from the microfilm records of the State Bureau of Flood Plain Management. Additional hydrologic and hydraulic data were obtained from the dam appliction, review report, and correspondence between the state's reviewing engineer and the designer. The design conforms with currently accepted structural engineering standards, although the design storm, as determined by the Central Jersey runoff curve, was somewhat smaller than contemporary standards suggest.

2.2 CONSTRUCTION

Although details pertaining to the actual construction of the dam were not available, correspondence and construction inspection reports by the State's reviewing engineer indicate that several design modifications were made during the construction process in response to unanticipated site conditions encountered. The changes were incorporated into as-built drawings, which basically reflect the dam's present configuration. The dam is situated in a region underlain by the Pre-Cambrian age Byram gneiss, a dense, hard, and characteristically banded metamorphic granitoid. The reservoir occupies what was once a small, rock-bound swampy depression caused by glacial scouring. The thin overburden in this area consists primarily of recent alluvium overlying glacial till. During the initial stages of construction, a trench was excavated in the overburden and the puddled clay core was extended down to the bedrock, thus forming a continuous cutoff to bedrock, from one abutment to the other.

2.3 OPERATION

There is no information available pertaining to dam operation. However, since the sole purpose of the dam is the impoundment of a lake for recreational purposes, the spillway appears adequate to perform, unattended, the water level regulation function at the dam.

2.4 EVALUATION

a. Availability

Sufficient engineering data were obtained to assess the structural stability of the embankment. The foundation stability was evaluated within the framework of data provided on the plans, the construction specifications, and geotechnical references pertaining to the damsite.

b. Adequacy

The field inspection and review of the available engineering data indicate that the dam is of conservative design and is structurally sound and well built. It is believed that the data available are adequate to render this assessment without the necessity of gathering additional information.

c. Validity

The available engineering data indicate that the design concepts are contemporary and conservative in nature. The dam appears to have been constructed according to the specifications and configuration depicted on the revised plans.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

Visual inspection of East Highland Lake Dam took place on March 24, 1981. At the time of the inspection, water was discharging through the weir notch at the spillway, which resulted in a tailwater at the low level drain outlet. Maintenance has apparently been neglected for many years, and while the overall condition of the spillway is generally good, the embankment is in fair to poor condition.

b. Dam

The dam crest and both slopes of the embankment are overgrown with trees, some of which are as large as 16 inches in diameter. A well traveled, sinuous footpath winds through the birch trees on the crest, giving the dam's alignment a somewhat irregular appearance. The riprap on the upstream slopes has been displaced at several locations, and in some areas where severe erosion has occurred, it is missing completely. Very severe erosion was observed in at least five locations on the upstream face of the dam. The erosion gullies, which extend from the dam crest to the lake edge, range from 7 to 15 feet wide and, in two locations, cut back into the embankment as far as the centerline of the crest. At one of these locations, a path is incised on the downstream face of the dam, further reducing the width of that portion of the crest which still remains at true design grade. The surface of the dam crest undulates slightly due to erosion and the foot traffic on the dam. Similarly, alignment of the upstream face is somewhat irregular due to surface and wave erosion. Since the spillway channel curves around the left end of the dam and continues some distance along the dam's toe, it was difficult to determine if there are seepage problems in that area. However, the remainder of the downstream slope of the dam appeared firm and dry with no signs of dampness anywhere in evidence except at the margins of the discharge channel. No signs of slouging or cracking were noted on the downstream slope of the embankment although several small rodent burrows were observed near the right abutment.

c. Appurtenant Structures

The concrete spillway at the left abutment is in a generally good condition although a light accumulation of debris, consisting of a tire and some wood, was noted at the weir. There is a light build-up of sediment at the left upstream side of the weir, but it is of no consequence since it does not interfere with the spillway hydraulics and bedrock is exposed immediately adjacent to both sides of the weir, obviating any concern over additional sediment loading on that structure. The weir has vertical bars exposed along the crest that, presumably, were designed to support a flashboard, although none is presently in place. The weir cap has a fresher appearance than the rest of the spillway, although all of the concrete was in fair to good condition. Some efflorescence and minor spalling were observed on the spillway's left sidewall, and at the downstream end of the spillway channel, the left wingwall exhibited a little more extensive concrete deterioration on its top surface. The spillway channel is constructed on bedrock that is very irregular and cluttered with angular boulders and some debris. Small trees are growing within the channel, primarily in accumulated silt along the left wall.

The outlet of the 12-inch-diameter drain pipe is almost completely blocked with silt and debris. While the concrete headwall appears in satisfactory condition, the top two courses of block at the valve chamber have been displaced several inches. The chamber has no manhole cover and the wheel has been broken off the valve stem, leaving only the stubs of the spokes radiating off the hub. The chamber contained a great deal of silt, leaves, and debris, and the valve itself appeared to be leaking.

d. Reservoir Area

The terrain surrounding the lake is modestly sloped and wooded with residential development on both the east and west shorelines. The south end of the lake is less heavily developed and swampy. Much of the shoreline is formed by well-defined bedrock outcrops and all homes surrounding the lake are several feet above dam crest elevation.

e. Downstream Channel

The area immediately downstream is a flat 200-foot-wide flood plain with stands of trees and secondary vegetation. The discharge is carried in a narrow meandering channel to a road culvert about 800 feet downstream. There are several homes and occupied trailers in the downstream area between the dam and the road. The elevations of the downstream structures are estimated to range between 6 and 8 feet above the stream channel. Downstream of the road, the channel enters a relatively large uninhabited marsh.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no formal operating procedures presently in existence although the Lake Association employs a permanent maintenance crew in addition to seasonal part-time help. This staff is responsible for groundskeeping, preventive maintenance, lake operations, and repairs associated with the community property and several lakes owned by the association. However, present operations appear to be restricted by funding limitations.

4.2 MAINTENANCE OF DAM

While the primary responsibility of the maintenance staff centers around groundskeeping, their duties also extend to repair work within their capability. However, it appears that the dam has received little maintenance for several years (as indicated by the thick growth on the embankment and the severe erosion on the upstream face of the dam).

4.3 MAINTENANCE OF OPERATING FACILITIES

There does not appear to be a formal maintenance program associated with the operational components of the dam and all exhibit signs of neglect and require remedial action.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no formal warning system in effect at this dam. While observant residents living near the dam could note conditions during heavy storms and notify local authorities, it was observed that the downstream homes are situated quite close to the channel and it is felt that a warning system is necessary to provide sufficient advance notice in case of a hazardous storm condition or dam failure.

4.5 EVALUATION OF OPERATIONAL ADEQUACY

The present operational procedures and community safeguards are deemed to be inadequate in view of the position of the dam and the downstream hazards. An overall community warning system should be developed along with a more intensive program of inspection and maintenance (see Section 7).

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data

Pursuant to the Recommended Guidelines for Safety Inspection of Dams, East Highland Lake Dam is a small size and significant hazard dam. Accordingly, the 100-year frequency storm was chosen as the design flood by the inspecting engineers. Inflow to the reservoir for the selected storm was computed utilizing precipitation data from Technical Paper 40 and Technical Memorandum NWS HYDRO-35 by the HEC-1 Dam Safety version computer program, which gave a peak inflow of 1,163 cfs. Routing this storm through the reservoir reduced the peak discharge to 321 cfs. Since the spillway capacity is 481 cfs, it can safely accommodate the 100-year storm and is therefore considered adequate.

b. Experience Data

There are no streamflow records available for this site, nor have records been kept regarding the dam's hydraulic performance since its construction.

c. Visual Observations

There are no indications of hydraulic problems at the dam although the spillway and channel contained scattered debris. Water was passing through the weir notch at the time of inspection and there was ample freeboard with no indications of recent extreme high water elevations at the dam. However, the low level drain appears inoperable at the present time.

d. Overtopping Potential

Employing the discharge and spillway capacities contained herein, overtopping would not occur in the event of the 100-year frequency design storm. There are no records or indications that the dam has ever been overtopped.

e. Drawdown

A 12-inch-diameter valve operated steel pipe is available for drawdown to elevation 101. The estimated time to drawdown is 11 days.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. While the dam appears structurally stable, several conditions were observed that could jeopardize the long-term integrity of the structure. The apparent lack of maintenance at the dam has resulted in extensive deterioration of the upstream slope; if not repaired, this could ultimately result in an embankment failure. Several large eroded areas on the upstream side of the embankment extend into the dam crest as far as the centerline of the dam. If the erosion in these areas continues unchecked, it will cut through the entire dam crest, breaching the dam since the concrete corewall does not extend the entire length of the dam. While the accumulation of debris in the spillway and its channel restricts the hydraulic capacity somewhat, it is not considered critical with respect to the structural integrity of the dam. Based on the stable condition of, and vegetation observed at, the left downstream toe of the embankment, high flows in the spillway flume and channel do not appear to pose a threat to that portion of the dam.

b. Design and Construction Data

From the review of the contract plans for the initial construction, the design appears to be well engineered, reflects a conservative approach, and employs conventional analytical techniques. Based on the visual observations of the condition of the dam and its hydraulic capacity, it is believed that additional studies are not necessary under the purview of Public Law 92-367.

c. Operating Records

While the dam appears to have performed satisfactorily since its construction, normal embankment maintenance and concrete repairs appear to have been completely neglected. There are no records available of operations, maintenance, or inspections since the original construction was completed.

d. Post Construction Changes

There have been no apparent hydraulic modifications or major structural improvements since the dam's initial installation. However, a portion of the

weir cap appears to be of more recent construction, exhibiting a fresher surface than the rest of the concrete in the spillway.

e. Seismic Stability

East Highland Lake Dam is located in Seismic Zone 1 in which seismic activity is slight and the additional structural loading imparted thereby is generally insignificant. Experience indicates that earthen dams in Zone 1 that are stable under static loading conditions will maintain their structural integrity when subjected to the negligible dynamic loads imposed by the weak seismicity characteristic of this area. This dam is considered to be structurally stable under static loading conditions.

SECTION 7 - ASSESSMENTS/RECOMMENDATIONS/ REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety

Subject to the inherent limitations of the Phase I visual inspection, East Highland Lake Dam appears to be in fair overall condition and the spillway can accommodate the 100-year design flood. No serious detrimental conditions were observed to render a structurally inadequate assessment, but the long-term integrity of the dam remains questionable until the remedial measures described below are completed.

The dam embankment, while designed and constructed in a conservative manner, exhibits many years of neglect. Continued inattention to the severe erosion at the crest will ultimately result in a dam breach. Since there is a potential for downstream flood damage in the event of this dam's failure, it is recommended that the dam be evaluated within the framework of the significant hazard classification.

b. Adequacy of Information

The information available is considered adequate with respect to the analyses and evaluation of the operation and stability of this dam.

c. Urgency

The remedial actions described below should be undertaken in the near future with the exception of those recommendations pertaining to the embankment erosion, which should be performed immediately.

d. Necessity for Further Study

In view of the general condition of this dam and its spillway capacity, which is more than adequate to accommodate the design storm, additional studies within the purview of Public Law 92-367 are considered unnecessary.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

a. Recommendations

The eroded areas and displaced riprap on the upstream face of the dam exhibit the greatest potential for impending problems at the dam and should be corrected immediately. The eroded areas should be filled and compacted with suitable embankment material and the riprap repositioned or replaced to prevent a reoccurrence of the condition. In addition, the owner should undertake the following repairs in the near future:

1. Remove all trees and brush from the dam, refill and regrade the dam crest, and reestablish a firm grass cover over the entire embankment.

2. The debris should be removed from the spillway and downstream channel.

3. The blow-off gate valve should be repaired and tested, the manhole cover replaced, the displaced block at the top of the manhole repaired, and the debris therein removed.

4. The deteriorated concrete at the spillway should be repaired.

5. The drain pipe should be cleared of the accumulated silt and debris.

b. O&M Maintenance and Procedures

It is recommended that the association's existing maintenance program be expanded and a periodic maintenance plan and operational procedures be developed. It is further recommended that the owners prepare an emergency action plan and warning system to minimize the damage potential downstream in the event of a dam failure.

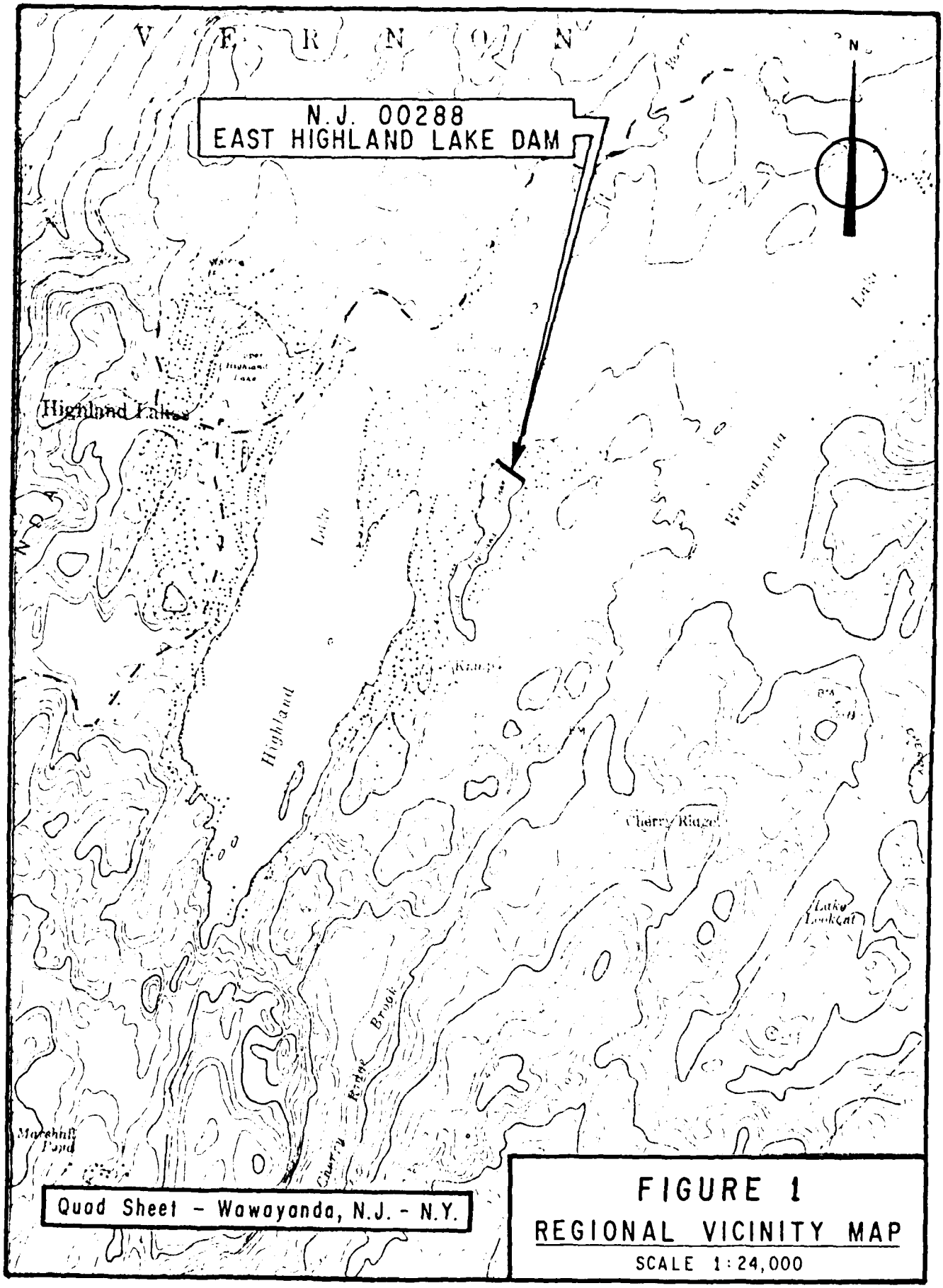
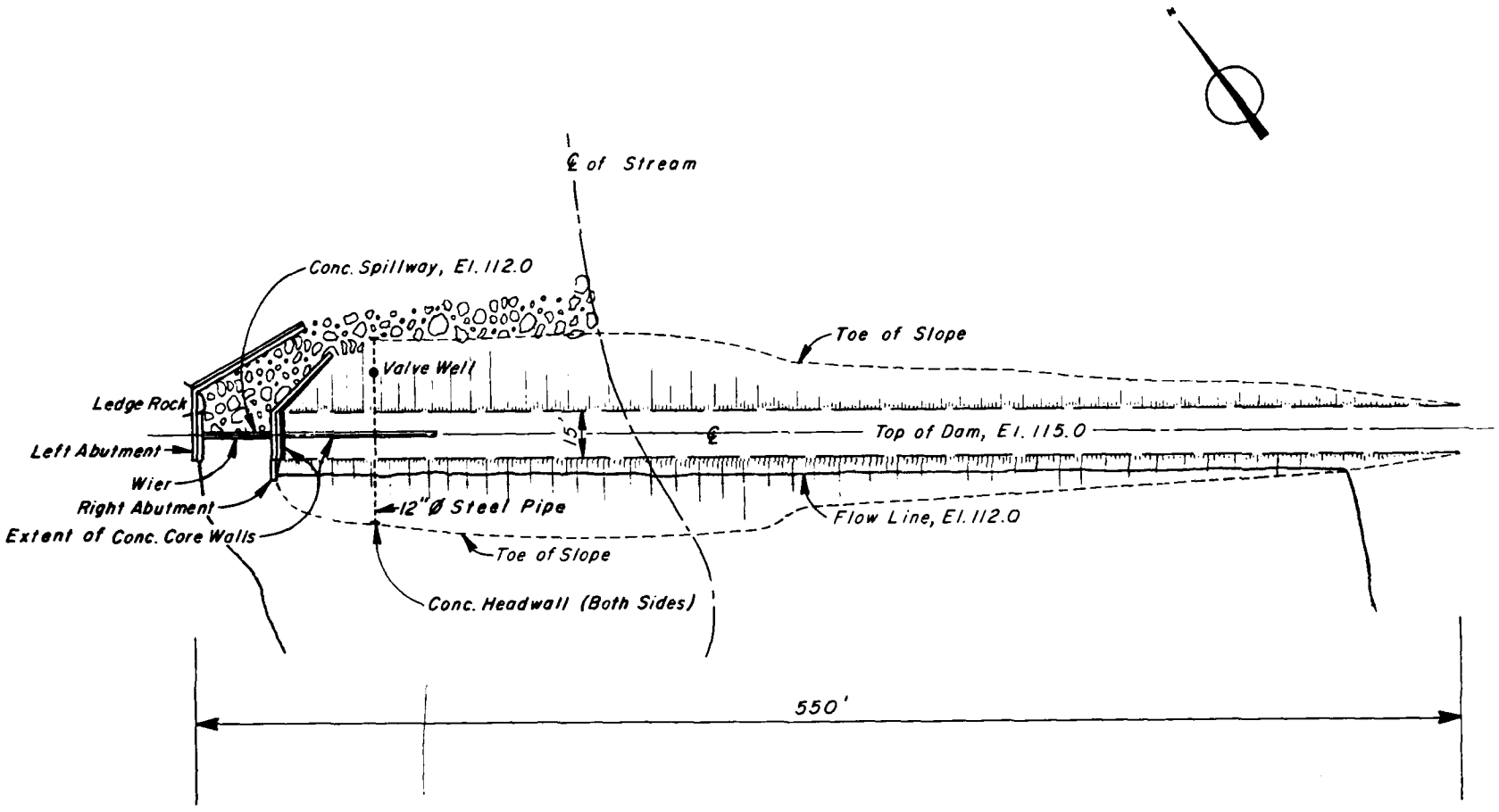


FIGURE 1

REGIONAL VICINITY MAP

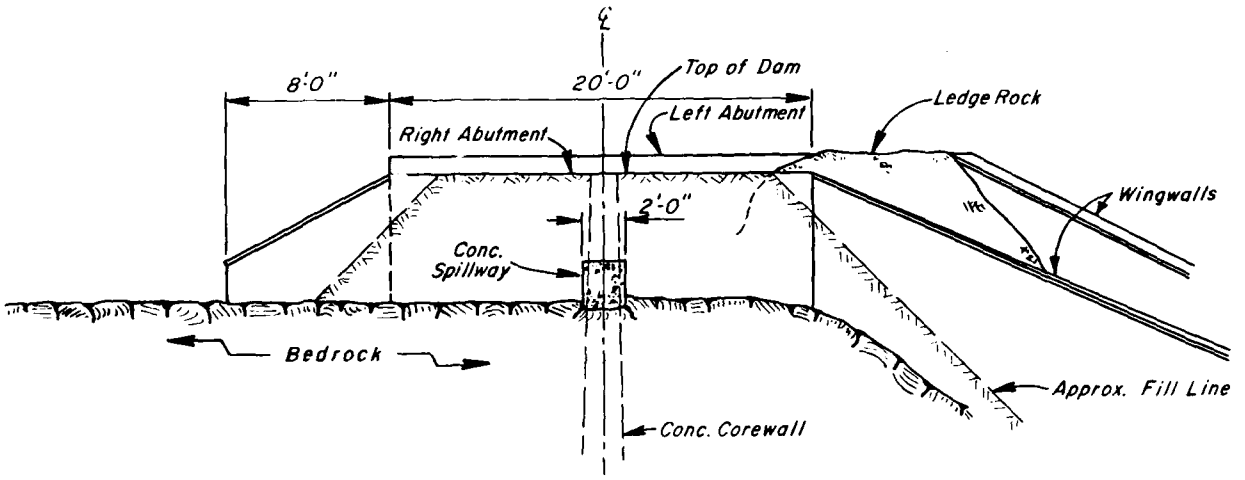
SCALE 1:24,000



PLAN OF EAST HIGHLAND LAKE DAM

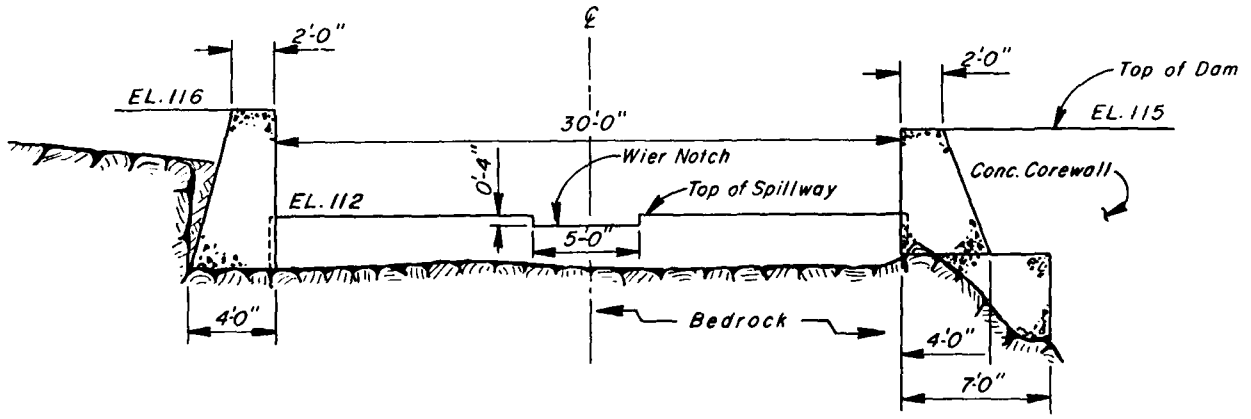
NOT TO SCALE

FIGURE 2



ELEVATION OF ABUTMENTS

NOT TO SCALE



SPILLWAY PROFILE

NOT TO SCALE

SPILLWAY DETAILS

EAST HIGHLAND LAKE DAM

FIGURE 3

Check List
Visual Inspection
Phase 1

Name Dam East Highland Lake Dam County Sussex State NJ Coordinators NJDEP

Date(s) Inspection March 24, 1981 Weather Sunny Temperature 50°

Pool Elevation at Time of Inspection 111.7 A.D. Tailwater at Time of Inspection 99.7 A.D.

Inspection Personnel:

T. Chapter

A. Perera

No representative of owner present.

A. Perera Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Severe erosion on upstream slope 35 feet left of spillway, 55 to 70 feet left of spillway, 145 to 152 feet left of spillway (erosion extends to center of crest here), and 200 to 210 feet left of spillway (erosion extends across crest almost reaching a path on the downstream slope).	Severe erosion on dam crest should be filled with compacted embankment.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Slightly irregular	Vertical alignment irregularity. Probably due to paths. Horizontal alignment irregular due to erosion, foot traffic, and tree over-growth. Crest should be regraded.
RIPRAP FAILURES	Riprap displaced in same areas as severe erosion.	Riprap should be replaced.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
Vegetable	Birch trees predominate , growing out of both u/s and d/s slopes and they are beginning to invade the crest.	Should be all cut and cleared, particularly on crest.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Grades smoothly one into another except for heavy footpath erosion behind right abutment (concrete spillway).	Eroded areas should be filled.
ANY NOTICEABLE SEEPAGE	None observed	
STAFF GAGE AND RECORDER	None	
DRAINS	None	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	N/A	
INTAKE STRUCTURE	None observed	
OUTLET STRUCTURE	12" diameter iron pipe with concrete headwall and cement block gate chamber. Outlet pipe almost completely blocked by debris and soil. Valve wheel broken off and valve is leaking. No cover on the manhole and debris around valve. Top two courses of block have shifted	
OUTLET CHANNEL	Rock outcrops just ahead (d/s) of spillway. Channel 15-20 feet wide covered with boulders, fallen trees, and some debris.	All components should be repaired, manhole cover should be replaced and the debris should be removed.
EMERGENCY GATE	None observed	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Concrete spalling at left wall. Recently constructed weir cap.	Spalling and concrete deterioration should be repaired.
APPROACH CHANNEL	Debris (old tires and lumber), partly filled in (left half of weir).	Needs cleaning and removal of silt.
DISCHARGE CHANNEL	Debris and small trees in channel.	Should be cleared.
BRIDGE AND PIERS	None	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER		

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Rocky and frequently steep slopes. Area developed with houses, wooden docks, and beaches.	
SEDIMENTATION	None observed except near spillway.	Should be removed.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Covered with boulders and fallen trees.	
SLOPES	400 feet downstream from dam, channel widens into a 200-300 foot wide flood plain.	
APPROXIMATE NO. OF HOMES AND POPULATION	One abandoned home in dilapidated condition 10 feet above channel elevation. Two occupied homes downstream from the first one within 300 feet of the dam. 800 feet downstream the channel is obstructed by a culvert under a paved road. In case of flooding, all could be inundated due to the flatness of the terrain. Two trailers in the area of the road are located in the floodplain 6-8 feet above the channel bottom.	Homes and road could sustain flood damage in the event of dam failure.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Available microfilm, NJDEP, 23 Prospect St., Trenton, NJ, 08625
REGIONAL VICINITY MAP	Available USGS Quandrangle, Wawayanda, NJ - NY
CONSTRUCTION HISTORY	Available microfilm NJDEP
TYPICAL SECTIONS OF DAM	Available microfilm NJDEP
HYDROLOGIC/HYDRAULIC DATA	Available microfilm NJDEP
OUTLETS - PLAN	Available NJDEP
- DETAILS	Not available
-CONSTRAINTS	" "
-DISCHARGE RATINGS	" "
RAINFALL/RESERVOIR RECORDS	" "

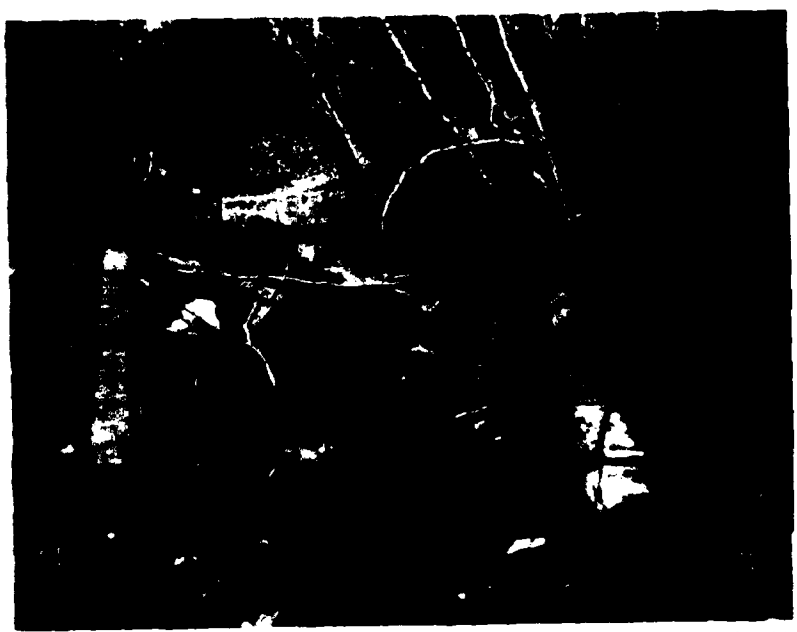
ITEM	REMARKS
SPILLWAY PLAN	Available NJDEP
SECTIONS	" "
DETAILS	" "
	" "
OPERATING EQUIPMENT PLANS & DETAILS	" "

ITEM	REMARKS
DESIGN REPORTS	Not Available
GEOLOGY REPORTS	" "
DESIGN COMPUTATIONS	" "
HYDROLOGY & HYDRAULICS	Available microfilm NJDEP
DAM STABILITY	Not Available
SEEPAGE STUDIES	" "
MATERIALS INVESTIGATIONS	" "
BORING RECORDS	" "
LABORATORY	" "
FIELD	" "
POST-CONSTRUCTION SURVEYS OF DAM	" "
BORROW SOURCES	" "

ITEM	REMARKS
MONITORING SYSTEMS	None
MODIFICATIONS	None
HIGH POOL RECORDS	Not available
POST CONSTRUCTION ENGINEERING	" "
STUDIES AND REPORTS	" "
PRIOR ACCIDENTS OR FAILURE OF DAM	" "
DESCRIPTION	" "
REPORTS	" "
MAINTENANCE	" "
OPERATION	" "
RECORDS	" "

March, 1981

Spillway & Dam Crest



March, 1981

Spillway Outlet Channel

March, 1981

Sedimentation At Left Wall Of Spillway

March, 1981

Debris At Right Wall Of Spillway

March, 1981

Manhole & Headwall For 12"Ø Outlet Pipe

March, 1981

Erosion On Dam Crest

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 0.5 square miles

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 111.7 A.D. (160 acre feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): -

ELEVATION MAXIMUM DESIGN POOL: -

ELEVATION TOP DAM: 115 A.D. (244 acre feet)

CREST: Spillway

a. Elevation 112.0
b. Type Concrete weir with 5 ft. wide notch at elev. 111.7
c. Width 24 inches
d. Length 25 feet
e. Location Spillover Center of spillway weir
f. Number and Type of Gates None

OUTLET WORKS:

a. Type 12-inch-diameter steel pipe
b. Location 80 feet from left abutment
c. Entrance inverts 111 A.D.
d. Exit inverts 100 A.D.
e. Emergency draindown facilities Same

HYDROMETEOROLOGICAL GAGES: None

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE: 481 cfs

A.D.-Assumed Datum

BY _____ DATE _____ **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A-_ OF 1

CHKD. BY _____ DATE _____ PROJECT _____

SUBJECT _____

1- [illegible] stream channel; All inflow overland

Length of overland flow = 3,400 ft.

L_m = 120 ft. $S_{ave} = \frac{120 \times 12}{3,400} = 3.5\%$

Assume overland velocity of 2 fps $\therefore t_c = \frac{3400}{2 \times 3600} = 0.47$ hr.

2.- Calif. Culvert Methodology

$$T_c = \left(\frac{11.9 \times .64^3}{120}\right)^{0.385} = 0.25 \text{ hr.}$$

3.- SCS Methodology

Gloucester soils - Group B
50% wooded (C_n=55); 35% meadow (C_n=58);
15% low density residential (C_n=61)
Adopted C_n = 58
S_{ave} = 3.5%
L_{ft} = 3,400 ft.

$$L_{mi} = \frac{L^{0.8}(S+1)^{0.7}}{1900 Y^{0.5}} = \frac{3400^{0.8} \times (3.5+1)^{0.7}}{1900 \times 3.5^{0.5}} = 0.42 \text{ hr.}$$

Lag time = 1.3 [illegible]

T_c = 0.[illegible] = 0.9 L + 0.[illegible] = [illegible]

L/S = [illegible]

BY _____ DATE _____

CHKD. BY _____ DATE _____

SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 1 OF 1

PROJECT _____

A = 0.05 SQ. MI.

LAG = 0.42 HRS

UNITGRAPH IS DEVELOPED BY THE HEC 1 DB COMPUTER PROGRAM (V 2 CARD)

BY _____ DATE _____ **LOUIS BERGER & ASSOCIATES INC.** SHEET NO A3 OF A13

CHKD. BY _____ DATE _____ PROJECT C-S-2716

SUBJECT _____ Test Storm: 100 Year Freq. [illegible]

Precipitation data from TP-40 & NOAA Technical Memorandum NWS Hydro-35

Time	Precip.	Δ	RΔ	Time	Precip.	Δ	RΔ
0.1	.91	.91	.03	3.1	4.30	.05	.91
0.2	1.46	.55	.03	3.2	4.34	.04	.35
0.3	1.81	.35	.03	3.3	4.38	.04	.23
0.4	2.07	.26	.03	3.4	4.41	.03	.17
0.5	2.30	.23	.02	3.5	4.45	.04	.12
0.6	2.46	.16	.03	3.6	4.48	.03	.10
0.7	2.63	.17	.02	3.7	4.52	.04	.09
0.8	2.77	.14	.04	3.8	4.56	.04	.08
0.9	2.89	.12	.03	3.9	4.60	.04	.07
1.0	3.00	.11	.03	4.0	4.63	.03	.06
1.1	3.10	.10	.03	4.1	4.66	.03	.06
1.2	3.20	.10	.04	4.2	4.69	.03	.05
1.3	3.29	.09	.03	4.3	4.72	.03	.05
1.4	3.36	.07	.03	4.4	4.75	.03	.05
1.5	3.44	.08	.04	4.5	4.78	.03	.04
1.6	3.51	.07	.04	4.6	4.82	.04	.05
1.7	3.58	.07	.05	4.7	4.85	.03	.04
1.8	3.65	.07	.05	4.8	4.87	.02	.04
1.9	3.71	.06	.05	4.9	4.90	.03	.04
2.0	3.76	.05	.05	5.0	4.93	.03	.04
2.1	3.82	.06	.05	5.1	4.96	.03	.03
2.2	3.87	.05	.07	5.2	4.98	.02	.03
2.3	3.92	.05	.07	5.3	5.01	.03	.03
2.4	3.97	.05	.07	5.4	5.04	.03	.03
2.5	4.02	.05	.10	5.5	5.06	.02	.03
2.6	4.07	.05	.11	5.6	5.09	.03	.03
2.7	4.12	.05	.14	5.7	5.12	.03	.03
2.8	4.17	.05	.16	5.8	5.15	.03	.02
2.9	4.21	.04	.26	5.9	5.17	.02	.03
3.0	4.25	.04	.55	6.0	5.20	.03	.02

BY _____ DATE Jun. 81

CHKD. BY _____ DATE _____

SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.

Great Miami Lake Levels

Stage - Discharge

SHEET NO [illegible] OF [illegible]

PROJECT [illegible]

Flow Over Spillway Notch L = 6' El. = 111.67*	Flow Over Spillway Crest L = 25' El. = 112.5*	Over Levee L = 515' El. = 116*

H	ΔH	Q	H	C	Q	H	ΔH	Q	ΣQ
0.33	3.0	3	0	3.0			2.7		3
1.33		23	1		75				99
2.33		68	2		212				280
3.33		91	3		390	0			491
4.33		130	4		600	1		1,391	2,121
5.33		150	5		839	2		3,930	4,921
6.33		238	6		1,102	3		7,225	8,566
7.33		293	7		1,389	4		11,124	12,911
8.33		351	8		1,697	5		15,546	17,604
9.33		427	9		2,025	6		20,436	22,888

* Above Sea Level

AS OF A/E

EAST HIGHLAND LAKE DAM
STAGE - DISCHARGE CURVE

BY ... DATE Jan. 81 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A2 ... OF ...

CHK'D. BY ... DATE ... Eastchester Creek Dam PROJECT ...

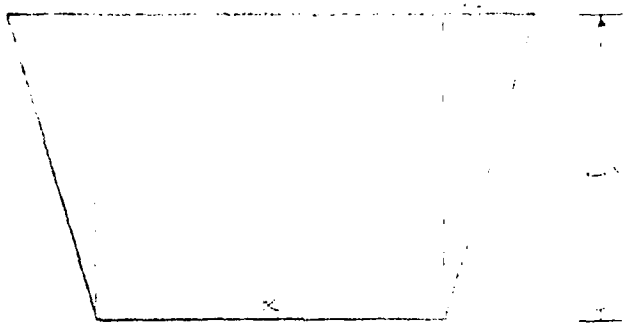
SUBJECT ... Surcharge Storage ...

Area of lake at normal pool elev. 11.0' = 26.6 ac.

Area of 122' contour [illegible] = 36.7 ac.

[illegible]

Elev. 122



El. 111.0'

Elev.	Ht. above Spillway (Δy) (ft.)	[illegible] (ft.)	Surcharge Storage (ac.-ft.)
[illegible]	0		
[illegible]	1	[illegible]	27
[illegible]	2	[illegible]	55
[illegible]	3	[illegible]	[illegible]
[illegible]	4	[illegible]	[illegible]
[illegible]	5	[illegible]	[illegible]
[illegible]	6	[illegible]	17[illegible]
[illegible]	7	[illegible]	21[illegible]
[illegible]	8	[illegible]	24[illegible]
[illegible]	9	[illegible]	27[illegible]
[illegible]	10	31.5	315

[illegible]

EAST HIGHLAND LAKE DAM
STAGE - DISCHARGE STORAGE
CURVE

BY _____ DATE _____ **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. _____ OF _____

CHKD. BY _____ DATE _____ PROJECT _____

SUBJECT _____

Hr. Head Spin. Det.	Elev. Storage (ac-ft)	Hr. Head Spillway Outflow (cfs)	Elev. Storage (ac-ft)
1	27	1.33	8
2	55	1.33	28
3	84	2.33	230
3.33	112	Top of Dam	3.33
5	140	4.33	2,111
6	171	5.33	4,757
7	210	6.33	8,000
8	240	7.33	11,000
9	279	8.33	15,634
10	310	9.33	21,000

BY _____ DATE _____ **LOUIS BERGER & ASSOCIATES INC.** SHEET NO _____ OF _____

CHKD. BY _____ DATE _____ PROJECT _____

SUBJECT _____

BY _____ DATE _____ **LOUIS BERGER & ASSOCIATES INC.** SHEET NO 4.12 OF 4.17

CHKD. BY _____ DATE _____ EAST HIGHLAND LAKE PROJECT _____

SUBJECT _____ HEC1 DB _____

```
A1  EAST HIGHLAND LAKE DAM  HEC-1 DB
A2  J. CERAVOLO
A3 JUNE 19 1981
B     100       0       6       0       0       0       0       0       0       0
B1      3
K       0       1                                       1
K1  INFLOW HYDROGRAPH TO RESERVOIR
M       0       2     0.5               0
O      60
O1   .03     .03     .03     .03     .02     .03     .02     .04     .03     .03
O1   .03     .04     .03     .03     .04     .04     .05     .05     .05     .05
O1   .05     .07     .07     .07     .10     .11     .14     .16     .26     .55
O1   .91     .35     .23     .17     .12     .10     .09     .08     .07     .06
O1   .06     .05     .05     .05     .04     .05     .04     .04     .04     .04
O1   .03     .03     .03     .03     .03     .03     .03     .02     .03     .02
T                                                     0.5     0.1
W2            0.42
X       0       0       1
K       1       2                                       1
K1  ROUTED FLOWS THROUGH RESERVOIR
Y                                       1       1
Y1      1                                                       -1
Y4 111.7      112     113     114     115     116     117     118     119     120
Y5      0       3      98     265     481    2126    4957    8566   12811   17604
$S      0    27.1    55.2    84.3   114.4   145.5   177.6   210.7   244.8
$E  111.7   112.7   113.7   114.7   115.7   116.7   117.7   118.7   119.7
$$  111.7
$D    115
K      99
```

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	0	6	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
3	0	0	0

INFLOW HYDROGRAPH TO RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	2	0.50	0.00	0.50	0.00	0.000	0	0	0

PRECIP PATTERN

0.03	0.03	0.03	0.03	0.02	0.03	0.02	0.04	0.03	0.03
0.03	0.04	0.03	0.03	0.04	0.04	0.05	0.05	0.05	0.05
0.05	0.07	0.07	0.07	0.10	0.11	0.14	0.16	0.26	0.55
0.91	0.35	0.23	0.17	0.12	0.10	0.09	0.08	0.07	0.06
0.06	0.05	0.05	0.05	0.04	0.05	0.04	0.04	0.04	0.04
0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.02

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	0.50	0.10	0.00	0.00

SUB-AREA RUNOFF COMPUTATION

UNIT HYDROGRAPH DATA

PRECIP DATA

NP	STORM	DAU	DAK
60	0.00	0.00	0.00

TC= 0.00 LAG= 0.42

RECESSION DATA

STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

UNIT HYDROGRAPH 20 END-OF-PERIOD ORDINATES, TC= 0.00 HOURS, LAG= 0.42 VOL= 1.00

57	1.0	371	494	511	451	355	236	166	120
79	60	42	29	21	15	11.	7.	5	4
3	2	1							

PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
*********	**********	**********	**********	**********

HYDROGRAPH ROUTING

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0	-1

BY _____ DATE _____

CHKD. BY _____ DATE _____

SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. _____ OF _____

PROJECT _____

END-OF-PERIOD FLOW

MO	DA	HR	MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO	DA	HR	MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1	01	0	06	1	0.03	0.00	0.03	0.	1	01	5	06	51	0.03	0.02	0.01	121
1	01	0	12	2	0.03	0.00	0.03	0.	1	01	5	12	52	0.03	0.02	0.01	111
1	01	0	18	3	0.03	0.00	0.03	0.	1	01	5	18	53	0.03	0.02	0.01	102
1	01	0	24	4	0.03	0.00	0.03	0.	1	01	5	24	54	0.03	0.02	0.01	93.
1	01	0	30	5	0.02	0.00	0.02	0.	1	01	5	30	55	0.03	0.02	0.01	86.
1	01	0	36	6	0.03	0.00	0.03	0.	1	01	5	36	56	0.03	0.02	0.01	79.
1	01	0	42	7	0.04	0.00	0.04	0.	1	01	5	42	57	0.02	0.01	0.01	75.
1	01	0	48	8	0.03	0.00	0.03	0.	1	01	5	48	58	0.03	0.02	0.01	71.
1	01	0	54	9	0.03	0.00	0.03	0.	1	01	5	54	59	0.03	0.02	0.01	68.
1	01	1	00	10	0.03	0.00	0.03	0.	1	01	6	00	60	0.02	0.01	0.01	64.
1	01	1	06	11	0.03	0.00	0.03	0.	1	01	6	06	61	0.03	0.02	0.01	59.
1	01	1	12	12	0.04	0.00	0.04	0.	1	01	6	12	62	0.03	0.02	0.01	53.
1	01	1	18	13	0.03	0.00	0.03	0.	1	01	6	18	63	0.03	0.02	0.01	44.
1	01	1	24	14	0.03	0.00	0.03	0.	1	01	6	24	64	0.03	0.02	0.01	35.
1	01	1	30	15	0.04	0.00	0.04	0.	1	01	6	30	65	0.03	0.02	0.01	26.
1	01	1	36	16	0.04	0.00	0.04	0.	1	01	6	36	66	0.03	0.02	0.01	18.
1	01	1	42	17	0.05	0.00	0.04	2.	1	01	6	42	67	0.03	0.02	0.01	13.
1	01	1	48	18	0.05	0.00	0.04	6.	1	01	6	48	68	0.03	0.02	0.01	9.
1	01	1	54	19	0.05	0.00	0.04	10.	1	01	6	54	69	0.03	0.02	0.01	6.
1	01	2	00	20	0.05	0.00	0.04	15.	1	01	7	00	70	0.03	0.02	0.01	4.
1	01	2	06	21	0.05	0.00	0.04	20.	1	01	7	06	71	0.03	0.02	0.01	3.
1	01	2	12	22	0.05	0.00	0.04	25.	1	01	7	12	72	0.03	0.02	0.01	2.
1	01	2	18	23	0.05	0.00	0.04	30.	1	01	7	18	73	0.03	0.02	0.01	2.
1	01	2	24	24	0.05	0.00	0.04	34.	1	01	7	24	74	0.03	0.02	0.01	1.
1	01	2	30	25	0.05	0.00	0.04	38.	1	01	7	30	75	0.03	0.02	0.01	1.
1	01	2	36	26	0.05	0.00	0.04	41.	1	01	7	36	76	0.03	0.02	0.01	1.
1	01	2	42	27	0.05	0.00	0.04	43.	1	01	7	42	77	0.03	0.02	0.01	0.
1	01	2	48	28	0.05	0.00	0.04	45.	1	01	7	48	78	0.03	0.02	0.01	0.
1	01	2	54	29	0.05	0.00	0.04	46.	1	01	7	54	79	0.03	0.02	0.01	0.
1	01	3	00	30	0.05	0.00	0.04	47.	1	01	8	00	80	0.03	0.02	0.01	0.
1	01	3	06	31	0.91	0.90	0.01	500.	1	01	8	06	81	0.03	0.02	0.01	0.
1	01	3	12	32	0.35	0.34	0.01	726.	1	01	8	12	82	0.03	0.02	0.01	0.
1	01	3	18	33	0.23	0.22	0.01	975.	1	01	8	18	83	0.03	0.02	0.01	0.
1	01	3	24	34	0.17	0.16	0.01	1134	1	01	8	24	84	0.03	0.02	0.01	0.
1	01	3	30	35	0.12	0.11	0.01	1163	1	01	8	30	85	0.03	0.02	0.01	0.
1	01	3	36	36	0.10	0.09	0.01	1084	1	01	8	36	86	0.03	0.02	0.01	0.
1	01	3	42	37	0.09	0.08	0.01	939	1	01	8	42	87	0.03	0.02	0.01	0.
1	01	3	48	38	0.08	0.07	0.01	770	1	01	8	48	88	0.03	0.02	0.01	0.
1	01	3	54	39	0.07	0.06	0.01	603	1	01	8	54	89	0.03	0.02	0.01	0.
1	01	4	00	40	0.06	0.05	0.01	523	1	01	9	00	90	0.03	0.02	0.01	0.
1	01	4	06	41	0.06	0.05	0.01	453	1	01	9	06	91	0.03	0.02	0.01	0.
1	01	4	12	42	0.05	0.04	0.01	383	1	01	9	12	92	0.03	0.02	0.01	0.
1	01	4	18	43	0.05	0.04	0.01	335	1	01	9	18	93	0.03	0.02	0.01	0.
1	01	4	24	44	0.05	0.04	0.01	300	1	01	9	24	94	0.03	0.02	0.01	0.
1	01	4	30	45	0.05	0.04	0.01	274	1	01	9	30	95	0.03	0.02	0.01	0.
1	01	4	36	46	0.05	0.04	0.01	253	1	01	9	36	96	0.03	0.02	0.01	0.
1	01	4	42	47	0.04	0.03	0.01	233	1	01	9	42	97	0.03	0.02	0.01	0.
1	01	4	48	48	0.04	0.03	0.01	217	1	01	9	48	98	0.03	0.02	0.01	0.
1	01	4	54	49	0.04	0.03	0.01	203	1	01	9	54	99	0.03	0.02	0.01	0.
1	01	5	00	50	0.04	0.03	0.01	191	1	01	10	00	100	0.03	0.02	0.01	0.

			SUM	5.20	4.26	0.94	13735
				0.132	0.108	0.024	389.04
				13733			
				389			
				4.26			
				108.20			
				114			
				140.			

				137.	137
				4.	4.
				4.26	4.26
				108.20	108.20
				114.	114
				140.	140

CFS	1163	33
CMS	33	
INCHES	4.26	
MM	108.20	
AC-FT	114.	
THOUS CU M	140.	

BY JLC DATE 6/21/91

CHKD. BY _____ DATE _____

SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.

SHEET NO 7 OF 11

PROJECT _____

ROUTED FLOWS THROUGH RESERVOIR

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

GLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

STAGE	111.70	112.00	113.00	114.00	115.00	116.00	117.00	118.00	119.00
FLOW	0.00	3.00	98.00	245.00	481.00	2126.00	4957.00	8566.00	12811.00
CAPACITY=	0	27	59	84	114	146	178	211	245
ELEVATION=	111	112	113	114	115	116	117	118	119

CMIN	SPWID	COQW	EXPW	ELEVW	COQA	CAREA	EXPA	ELEVA
111.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
115.0	0.0	0.0	0

END-OF-PERIOD HYDROGRAPH ORDINATES

MO DA	HR.MN	PERIOD	HOURS	INFLOW	OUTFLOW	STORAGE	STAGE
1.01	0.06	1	0.10	0.	0.	0.	111.7

1.01	0 12	2	0.20	0.	0.	0.	111.7	1.01	3.18	33	3.30	975.	70.	27.	112.7
1.01	0 18	3	0.30	0.	0.	0.	111.7	1.01	3.24	34	3.40	1134.	98.	35.	113.0
1.01	0.24	4	0.40	0.	0.	0.	111.7	1.01	3.30	35	3.50	1163.	148.	44.	113.3
1.01	0 30	5	0.50	0.	0.	0.	111.7	1.01	3.36	36	3.60	1084.	194.	52.	113.6
1.01	0 36	6	0.60	0.	0.	0.	111.7	1.01	3.42	37	3.70	939.	233.	58.	113.8
1.01	0 42	7	0.70	0	0	0.	111.7	1.01	3.48	38	3.80	770.	262.	63.	114.0
1.01	0 48	8	0.80	0	0.	0.	111.7	1.01	3.54	39	3.90	634.	287.	67.	114.1
1.01	0 54	9	0.90	0	0.	0.	111.7	1.01	4.00	40	4.00	524.	304.	69.	114.2
1.01	1 00	10	1.00	0	0	0	111.7	1.01	4.06	41	4.10	434.	315.	71.	114.2
1.01	1 06	11	1.10	0	0	0	111.7	1.01	4.12	42	4.20	363.	320.	71.	114.3
1.01	1 12	12	1.20	0	0.	0.	111.7	1.01	4.18	43	4.30	305.	321.	71.	114.3
1.01	1 18	13	1.30	0.	0.	0.	111.7	1.01	4.24	44	4.40	260.	318.	71.	114.3
1.01	1 24	14	1.40	0	0.	0	111.7	1.01	4.30	45	4.50	224.	314.	71.	114.3
1.01	1 30	15	1.50	0	0	0.	111.7	1.01	4.36	46	4.60	196.	308.	70.	114.3
1.01	1 36	16	1.60	0	0	0.	111.7	1.01	4.42	47	4.70	173.	300.	69.	114.3
1.01	1 42	17	1.70	2	0	0	111.7	1.01	4.48	48	4.80	155.	292.	68.	114.3
1.01	1 48	18	1.80	10	0	0	111.7	1.01	4.54	49	4.90	140.	284.	66.	114.3
1.01	1 54	19	1.90	24	0	0.	111.7	1.01	5.00	50	5.00	131.	275.	65.	114.3
1.01	2 00	20	2.00	44	0	0	111.7	1.01	5.06	51	5.10	121.	266.	64.	114.3
1.01	2 06	21	2.10	65	0	1	111.7	1.01	5.12	52	5.20	111.	259.	63.	114.3
1.01	2 12	22	2.20	84	1	2	111.8	1.01	5.18	53	5.30	102.	252.	62.	113.9
1.01	2 18	23	2.30	100	1	2	111.8	1.01	5.24	54	5.40	93.	245.	60.	113.9
1.01	2 24	24	2.40	118	1	3	111.8	1.01	5.30	55	5.50	85.	237.	59.	113.8
1.01	2 30	25	2.50	137	2	4	111.9	1.01	5.36	56	5.60	79.	230.	58.	113.8
1.01	2 36	26	2.60	158	2	5	111.9	1.01	5.42	57	5.70	75.	223.	57.	113.7
1.01	2 42	27	2.70	185	3	7	112.0	1.01	5.48	58	5.80	71.	216.	55.	113.7
1.01	2 48	28	2.80	217	4	8	112.0	1.01	5.54	59	5.90	68.	209.	54.	113.7
1.01	2 54	29	2.90	255	11	10	112.1	1.01	6.00	60	6.00	64.	202.	53.	113.6
1.01	3 00	30	3.00	346	19	13	112.2	1.01	6.06	61	6.10	59.	196.	52.	113.6
1.01	3 06	31	3.10	530	31	16	112.3	1.01	6.12	62	6.20	53.	189.	51.	113.5
1.01	3 12	32	3.20	705	48	21	112.5	1.01	6.18	63	6.30	44.	182.	50.	113.5

BY_____DATE_____ **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. ___ OF ___

CHKD. BY_____DATE_____ PROJECT _____

SUBJECT _____

1.01	6.24	64	6.40	35.	175	49.	113.5
1.01	6.30	65	6.50	26.	168	47.	113.4
1.01	6.36	66	6.60	18.	161.	46.	113.4
1.01	6.42	67	6.70	13.	154.	45.	113.3
1.01	6.48	68	6.80	9.	148.	44.	113.3
1.01	6.54	69	6.90	6.	141.	43.	113.3
1.01	7.00	70	7.00	4.	134.	42.	113.2
1.01	7.06	71	7.10	3.	128.	41.	113.2
1.01	7.12	72	7.20	2.	122.	40.	113.1
1.01	7.18	73	7.30	2.	116.	39.	113.1
1.01	7.24	74	7.40	1.	111.	38.	113.1
1.01	7.30	75	7.50	1.	106.	37.	113.0
1.01	7.36	76	7.60	0.	100.	36.	113.0
1.01	7.42	77	7.70	0.	97.	35.	113.0
1.01	7.48	78	7.80	0.	94.	34.	113.0
1.01	7.54	79	7.90	0.	91.	34.	112.9
1.01	8.00	80	8.00	0.	89.	33.	112.9
1.01	8.06	81	8.10	0.	86.	32.	112.9
1.01	8.12	82	8.20	0.	84.	31.	112.9
1.01	8.18	83	8.30	0.	82.	31.	112.8
1.01	8.24	84	8.40	0.	80.	30.	112.8
1.01	8.30	85	8.50	0.	77.	29.	112.8
1.01	8.36	86	8.60	0.	75.	29.	112.8
1.01	8.42	87	8.70	0.	73.	28.	112.7
1.01	8.48	88	8.80	0.	71.	28.	112.7
1.01	8.54	89	8.90	0.	69	27.	112.7
1.01	9.00	90	9.00	0.	67.	26.	112.7
1.01	9.06	91	9.10	0.	65.	26.	112.7
1.01	9.12	92	9.20	0.	63.	25.	112.6
1.01	9.18	93	9.30	0.	62.	25.	112.6
1.01	9.24	94	9.40	0.	60.	24.	112.6
1.01	9.30	95	9.50	0.	58.	24	112.6
1.01	9.36	96	9.60	0.	56.	23.	112.6
1.01	9.42	97	9.70	0.	55.	23.	112.5
1.01	9.48	98	9.80	0.	53.	22.	112.5
1.01	9.54	99	9.90	0.	52.	22.	112.5
1.01	10.00	100	10.00	0.	50.	22.	112.5

PEAK OUTFLOW IS	321. AT TIME	4.30 HOURS				
	CFS	321.	176.	111.	111.	11123.
	CMS	9	5.	3.	3	315
	INCHES		3.28	3.45	3.45	3.45
	MM		83.29	87.60	87.60	87.60
	AC-FT		87.	92.	92.	92
	THOUS CU M		108.	113.	113.	113.

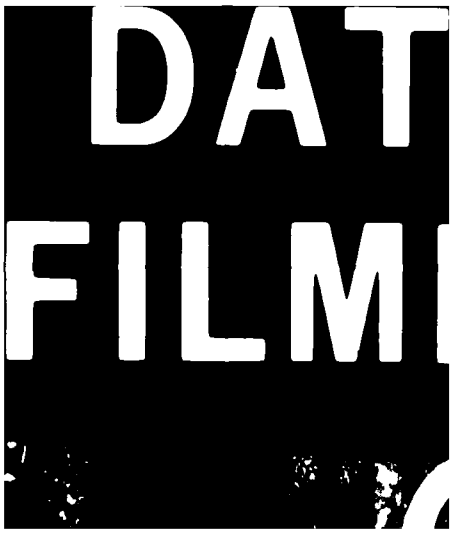
RUNOFF SUMMARY, AVERAGE FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)

		AREA IN SQUARE MILES(SQUARE KILOMETERS)				
HYDROGRAPH AT	1	1163.	289	137	137	0.50
		(32.94)(	6.48)(	3.89)(	3.89)(	1.29)
ROUTED TO	2	321.	176	111.	111	0.50
		(9.08)(	4.99)(	3.15)(	3.15)(	1.29)

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	111.70	111.70	115.00
STORAGE	0	0	93
OUTFLOW	0.	0.	481.

MAXIMUM RESERVOIR W.S ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
114.26	0.00	71	321.	0.00	4.30	0.00


DAT
FILM